

10/581768

JAP20 Rec'd PCT/PTO 06 JUN 2006

Method of providing a seat back involving the use of a design manikin

## 1. Field of the Invention

[0001] This invention relates to a method of designing seating assemblies, and more particularly, to a process for designing the contours for the seat back of a seating assembly for maximum occupant support and comfort.

## 2. Description of the Related Art

[0002] Seat design has become increasingly important with respect to the design of automobiles as engineers attempt to design seating assemblies that are both safe and comfortable, however, consumers are commonly dissatisfied with automobile seat comfort, or lack thereof. Upon close analysis, the most highly ranked dissatisfaction is with poor or uncomfortable lumbar support. These dissatisfactions refer to either the lumbar mechanism or the lower back seating contour or both.

[0003] The greatest challenge engineers face when designing seats has to do with the multitudes of different body sizes and shapes. When designing seats, a supplier typically samples the complete population with respect to both morphology (shape) and anthropometry (structure), in order to have representative models for use in seat design. It is important when designing seat backs to also consider the specific structure of the spinal column, since the inherent structure of the spinal column is consistent over the entire population.

[0004] The spinal column has a specific number of vertebrae – a taller person does not have more vertebrae, but instead has bigger vertebrae. The placement of a person's vertebrae dictates that person's lumbar curve, or lordosis. The length of this curve depends on the torso length of the particular individual, meaning the apex of this curve can vary from person to person by an amount up to about 120mm. This means that designing a seat back to accommodate such a varying population becomes challenging at best. There is a need in the art for a method of better designing the

curvature of a seat back to accommodate and be comfortable for a significant portion of the population.

[0005] The invention uses an inside-out design methodology, which considers an occupant to the seat rather than the seat to the occupant, and anatomical landmarks of the occupant to support the lower back. This is an alternate approach to the more common lumbar support concept. This alternate approach allows a designer to design a seat back based on cross-sectional human dimensions (transverse plane), rather than longitudinal dimensions (saggital plane). This design also offers a larger surface contact area (the pelvis) rather than the traditional lumbar (lumbar spine area). In addition, the present invention assists in controlling dynamic effects (micro motions) transferred to the spinal muscles (erector spinae) that are associated with road vibration transmissions. These vibration transmissions elicit a rapid firing of the spinal muscles ultimately leading to muscle fatigue condition and thus, discomfort.

#### **SUMMARY OF THE INVENTION**

[0006] According to one aspect of the invention, a method for shaping a centerline for a seat back of a seat assembly is provided. The process involves the use of a design manikin having a hip point and a torso line. The method defines a lumbar apex reference point above the hip point along the torso line. A lumbar shape reference circle defined as being behind the torso line and spaced apart therefrom. A forward lumbar prominence line is created parallel to the torso line and tangential to the lumbar shape reference circle. A rearward lumbar prominence line, which is parallel to the forward lumbar prominence line, is created and spaced reward from the forward lumbar prominence line. A centerline is then shaped for the seat back, wherein the centerline incorporates the forward and rearward lumbar prominence lines and the lumbar shape reference circle.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

[0007] Advantages of the present invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

[0008] Figure 1 is a plan view of a design manikin with the hip point and torso line determined as explained in the process below;

[0009] Figure 2 is a plan view of the torso of a design manikin with various construction shapes used to determine the contours of a seat back as described in the process;

[0010] Figure 3 is a plan view of the construction of a apex horizontal contour;

[0011] Figure 4 is a plan view of the construction of a lower horizontal seat back contour;

[0012] Figure 5 is a plan view of the construction of an upper horizontal contour;

[0013] Figure 6 is a plan view of the construction of the middle seat back bolster contour;

[0014] Figure 7 is a plan view of the construction of the upper seat back bolster contour;

[0015] Figure 8 is a plan view of the overall seat back contours as constructed in the process as described herein; and

[0016] Figure 9 is a perspective view of a seat assembly inside a motor vehicle, partially cut away.

#### **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT**

[0017] Referring to Figure 1, the process of developing seat contours incorporates a design process taken from the perspective of the occupant. To this end, parameters of a design manikin 14 are required. More specifically, a hip point 10 ("Hpt") and a torso line 12 of the design manikin 14 must be known. The parameters of the design manikin 14 are chosen based on a particular vehicle environment in which the seat assembly is to be located. Once these reference parameters have been

defined, the method can then begin the construction of the seat back contour that will optimally support the full range of intended occupants.

[0018] The first main step of the method is to determine a centerline 15 of a seat back 17, best seen in Figure 9. The centerline 15 is the relatively vertical line (usually rotated rearward relative to vertical based on the intended design recline angle of the seat, which varies according to the goal of the design, and is generally parallel to the design manikin torso line) of the seat back 17. The centerline 15 will determine a contour of the seat back 17 which will be the basis of how a seat assembly 19 incorporating the seat back 17 will support its occupants.

#### Determining the Lumbar Support Shape with a Lumbar Centerline Contour

[0019] Referring to Figure 2, and because the Hpt 10 and torso line 12 of the design manikin 14 have been defined, the next step is to create the proper lumbar support shape based on the proper lumbar apex location and surface radius in this region. This is accomplished by constructing a lumbar apex reference point 16 vertically upward from the Hpt 10 along the torso line 12 a specified distance based on anthropometric landmarks. Using the lumbar apex reference point 16 as the origin, a rearward lumbar apex reference line 18 is extended rearward and perpendicular to the torso line 12 in such a manner that the end of the lumbar apex reference line 18 is substantially distant from the origin. This rearward lumbar apex reference line 18 is then used as a reference to establish the desired amount of lumbar support prominence. In order to achieve this, two lines perpendicularly related to the rearward lumbar apex reference line must be created.

[0020] The first perpendicularly related line, the rearward lumbar prominence line 20, extends between a rearward origin 22 and a rearward endpoint 24. The rearward origin 22 is located along the rearward lumbar apex reference line 18 at a specified distance forward of an intersection of a rearward surface 25 of the design manikin 14 and the rearward lumbar apex reference line 18. The rearward lumbar prominence line 20 extends from the rearward origin 22 in a relatively vertical sense parallel with the torso line 12 to the rearward endpoint 24, which is distant from the rearward origin 22.

[0021] The second perpendicularly related line, the forward lumbar prominence line 30, extends between a forward origin 32 and a forward endpoint 34. The forward origin 32 is located along the rearward lumbar apex reference line 18 at a specified distance forward of the rearward origin 22. The specified distance is representative of a total lumbar deflection desired. The forward lumbar prominence line 30 extends from the forward origin 32 in a relatively vertical sense, parallel with the torso line 12 to the forward endpoint 34 which is distant from the forward origin 32.

[0022] A lumbar shape reference circle 40 is then created having its center 42 located along the rearward lumbar apex reference line 18 and wherein the rearward lumbar prominence reference line 20 is tangent thereto. The radius of the lumbar shape reference circle 40 is representative of the desired shape of the lumbar support region and is determined based on anthropometric dimensions of the human body.

#### Determining the Overall Seat Back Shape with an Overall Centerline Contour

[0023] Using the rearward lumbar prominence reference line 20, an upper seat back contour transition reference point 50 is created along the rearward lumbar prominence reference line 20 a distance above the rearward origin 22 based on anthropometric landmarks of the human body. A lower seat back contour transition reference point 52 is created at the tangency location of the lumbar shape reference circle 40 and the forward lumbar prominence reference line 30. A transition shape 54 extending between the lower seat back contour transition reference point 52 and the upper seat back contour transition reference point 50 is created by means of a shaping function. The shaping function is a spline function. It should be appreciated by those skilled in the art that functions other than the spline function may be used without changing the scope of the invention. A lower seat back contour endpoint 60 is identified by an intersection of the lumbar shape reference circle 40 and a seat cushion contour 62, representing a contour of a seat cushion 63.

[0024] The centerline 15, which is used to determine the overall shape of the seat back 17, is identified as the shape extending from the lower seat back contour endpoint 60 generally vertically extending along the lumbar shape reference circle 40

to the lower seat back contour transition reference point 52, from the lower seat back transition reference point 52 along the transition shape 54, accomplished by means of the mathematical shaping function, to the upper seat back contour transition reference point 50, from the upper seat back contour transition reference point 50 along the rearward lumbar prominence line 20 to an upper seat back contour end point 66, determined by the required design height of the seat back 17, which can vary depending on the seat assembly 19 being designed.

#### Determining the Horizontal (Cross-Car) Seat Back Contours

[0025] The second main step of this method is the cross-car (horizontal) contour of the seat back 17. This is the relatively horizontal shape of the seat back 17 and is perpendicularly related to the centerline 15 at specific locations along the seat back 17. The specific locations of the specified cross-car contours are determined based on specific anthropometric landmarks of the human body. These have been translated to specific locations of the design manikin 14 to ensure a consistent design methodology. This design feature provides proper support to the occupant's back while not exerting excessive load onto the spinal processes (vertebral bodies of the spine). Minimizing load to these bodies improves both physical and perceived occupant comfort.

[0026] Referring to Figures 3-5, two copies of the centerline 15 are made. These two copies, are referred to as outer contour lines 70 (the first outer contour 70a and the second outer contour 70b, respectively) and are located horizontally outward and parallel to the centerline 15. The distance between each of the outer contour lines 70 and the centerline 15 is determined by the anthropometry of the human body. Each outer contour line 70 shall be adjusted perpendicularly forward of the torso line 12, such that each outer contour 70 is forward of the centerline 15. Two additional copies of the centerline 15 are constructed. These two copies are inner contour lines 72. The inner contour lines 72 are horizontally located outward and parallel to the centerline 15. The distance between the centerline 15 and each of the inner contour lines 72 is determined by the anthropometry of the human body. Each inner contour

line 72 shall be forwardly adjusted along a line perpendicular to the torso line 12, such that it is forward of the centerline 15 and rearward of the outer contour lines 70.

[0027] Referring to Figure 3, an apex horizontal contour 74 is constructed to define a portion of the horizontal contour. The apex horizontal contour 74 spans across the middle of the seat back 17. An apex contour point 76 located at the intersection of a plane perpendicular to the torso line 12 and containing the lumbar apex reference point 16 and the centerline 15 is constructed. Then, an apex circle 78 is constructed having a radius defined based on the anthropometry of the human body. The apex circle 78 resides in a plane that is perpendicular to the centerline 15, intersects each outer contour line 70, intersects each inner contour line 72, and contains the apex contour point 76. The apex horizontal contour 74 is the line having a first outer point 80 defined by the intersection of the apex circle 78 and the first outer contour 70a, intersection points 82 and 84 defined by the intersection of the apex circle 78 and each of the inner contour lines 72, a center point 86 defined by the intersection of the apex circle 74 and the centerline 15, and a second outer point 88 defined by the intersection of the apex circle 78 and the second outer contour 70b.

[0028] Referring to Figure 4, a lower horizontal contour 174 is constructed to define a portion of the horizontal contour. A lower horizontal construction point 176 located at the intersection of a plane perpendicular to the design manikin torso line 12 and containing the design manikin Hpt 10 and the centerline 15 is constructed. Then, a lower circle 178 is constructed, having a radius one and half times the radius of the apex circle 78, and residing in a plane perpendicular to the centerline 15, intersects each outer contour line 70, intersects each inner contour line 72, and contains the lower horizontal construction point 176. The lower horizontal contour 174 is the line having a first outer point 180 defined by the intersection of the lower circle 178 and the first outer contour 70a, intersection points 182 and 184 defined by the intersection of the lower circle 178 and each of the inner contour lines 72, a center point 186 defined by the intersection of the lower circle 174 and the centerline 15, and a second outer point 188 defined by the intersection of the lower circle 178 and the second outer contour 70b.

[0029] Referring to Figure 5, an upper horizontal contour 274 is constructed to define a portion of the horizontal contour. An upper horizontal seat back contour reference point 90 located vertically above the lumbar apex reference point 16 at a desired distance based on the anthropometry of the human body is constructed. Then, an upper horizontal construction point 276 located at the intersection of a plane perpendicular to the torso line 12 and containing the upper horizontal seat back contour reference point 90 and the centerline 15 is constructed. Next, an upper circle 278 is constructed, having a radius twice the size of the radius of the apex circle 78. The upper circle 278 resides in a plane perpendicular to the centerline 15, intersecting each outer contour line 70 (adjusted 10mm outward from the location when constructing the lower and apex horizontal contours), intersecting each inner contour line 72 (adjusted 10mm outward from the location when constructing the lower and apex horizontal contours), and containing the upper horizontal construction point 276. The upper horizontal contour 274 is the line having a first outer point 280 defined by the intersection of the upper circle 278 and the first outer contour 70a, intersection points 282 and 284 defined by the intersection of the upper circle 278 and each of the inner contour lines 72, a center point 286 defined by the intersection of the upper circle 274 and the centerline 15, and a second outer point 288 defined by the intersection of the upper circle 278 and the second outer contour 70b.

[0030] The overall seat back contour 92 as shown in Figure 8, is defined by the shape resulting from connecting the outer points 180, 188 and the center point 184 of the lower horizontal contour 174 to the outer points 80, 88 and the center point 84 of the apex horizontal contour 74, respectively, by means of a mathematical shaping formula. The overall seat back contour 92 is further defined by the shape resulting from the surface connecting the outer points 80, 88 and center point 84 of the apex horizontal contour 74 to the outer points 280, 288 and the center point 284 of the upper horizontal contour 274, respectively, using the spline function, which includes a mathematical shaping formula. A mathematical shaping function is necessary to connect the contours into a single, consistent, smooth contour is necessary to connect the contours, as the shape will not be consistent.

[0031] The final main step of this method is the bolster contours for the bolsters 96 of the seat back 17. The bolsters 96 are the relatively extended portions along the lateral edges of the seat back 17 designed to hold the occupant in the seat during cornering as well as to provide stabilizing support of the occupant during standard driving (straight driving). The shape of the bolster 96 is angularly related to the centerline contours at specific horizontal (width) locations. The proper placement in the horizontal direction as well as the proper angular relationship allows the seat back 17 to accommodate a full range of intended users.

[0032] Referring to Figure 6, apex bolster contours 98 are constructed to define a portion of the bolsters 96. First, an apex bolster line 100 is constructed by connecting the outer points 80, 88 of the apex horizontal contour 74. Then, apex bolster reference lines 102, lines having their origin at each outer point 80, 88 of the apex horizontal contour 74 and extending substantially forward and rotated outwardly 30 degrees from a respective pair of planes perpendicular to the apex bolster line 100 and containing the apex horizontal contour 74 are constructed. An inner apex bolster point 104 for each apex bolster contour 98 is defined by the intersection of the apex bolster reference line 102 and a first line 107 perpendicularly forward 60mm and parallel to the apex bolster line 100. Next, an outer apex bolster point 106 for each apex bolster contour 98 is defined by the intersection of the apex bolster reference line 102 and a second line 108 perpendicularly forward 115mm and parallel to the apex bolster line 100. The apex bolster contours 98, respectively inboard 98a and outboard 98b, are the segments 109 of each apex bolster reference line 102 extending between the inner apex bolster point 104 and the outer apex bolster point 106.

[0033] Referring to Figure 7, upper bolster contours 298 are constructed to define a portion of the bolsters 96. First, an upper bolster line 200 is constructed between the outer points 280, 288 of the upper horizontal contour 274. Then, upper bolster reference lines 202, lines having their origin at each outer point 280, 288 of the upper horizontal contour 274 and extending substantially forward and rotated outwardly 30 degrees from a respective pair of planes perpendicular to the upper bolster line 200 and containing the upper horizontal contour 274, are constructed. An inner upper bolster point 204 for each upper bolster contour 298 is defined by the

intersection of the upper bolster line 200 and the upper horizontal contour 274. Next, an outer upper bolster point 206 for each apex bolster contour 98 is defined by the intersection of the upper bolster reference line 202 and a third line 207 perpendicularly forward 60mm and parallel to the upper bolster line 200. The upper bolster contours 298, respectively inboard 298a and outboard 298b, are the segments 209 of each upper bolster reference line 202 extending between the inner upper bolster point 104 and the outer upper bolster point 106.

[0034] Next, overall bolster contours 110, a pair of surfaces inboard 110a and outboard 110b respectively, are constructed by connecting the bolster points 204, 204 of the upper bolster contour 298 to the bolster points 104, 106 of the apex bolster contour 98, respectively, by means of a mathematical shaping formula. Each seat back bolster surface inboard 110a and outboard 110b, are located relatively in space such that they do not necessarily make contact with the overall seat back contour 92.

[0035] The invention has been described in an illustrative manner, and it is to be understood that the terminology that has been used, is intended to be in the nature of words of description rather than of limitation. Accordingly, any measurements used were for one particular application of the process and one skilled in the art will recognize that such measurements may be varied depending on the goals of the particular application.

[0036] Many modifications and variations of the present invention are possible in light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims, the invention may be practiced other than as specifically described.